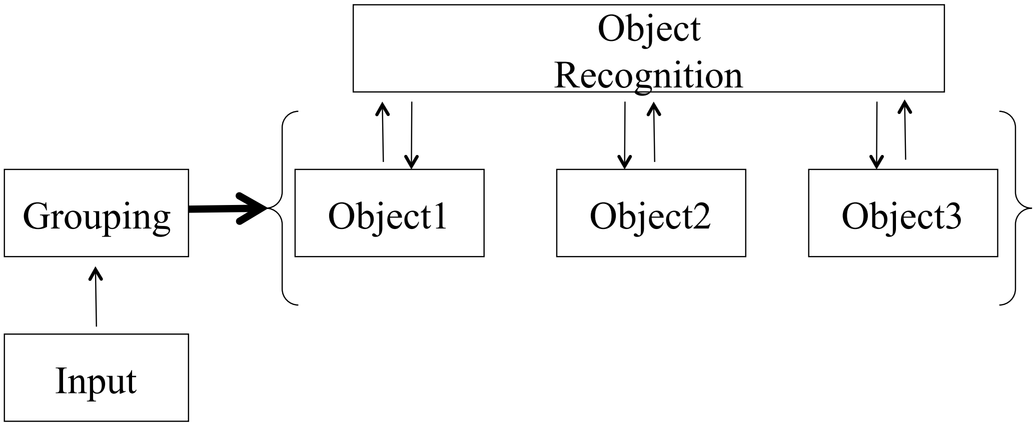
Thought Question

Imagine you are building an artificial vision system. Your system first uses grouping principles to determine how many objects are in the scene. Next, the features of each object are extracted. Finally, each object is identified serially, by comparing the features for that object with feature lists stored in memory.

How will your system behave if you ask it to identify an object presented in isolation as compared with an object in a complex scene?

Is this similar to the pattern we would expect to see for humans? Why or why not?

Breaking down the model



Object Recognition

Grouping

Object1

Object2

Object3

Input

** HEY, YOU! **

Attention

Two types of attention

- **Focused attention**
  - Select to attend to some, ignore others
  - Present multiple stimuli and ask for response to only one
- **Divided attention**
  - Try to do multiple tasks at same time
  - Present multiple stimuli and ask for response to more than one

Outline

- **Sensory store (Iconic memory)**
  - limits on perception
    - change blindness
    - visual report
- **Focused attention**
  - **When does selection occur?**
    - early vs. late selection
    - text reading, cocktail party effect, dichotic listening
    - ERP evidence
  - **What type of information is selected?**
    - spaces
    - objects

Sensory Store

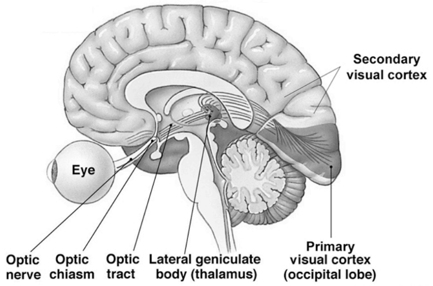

Secondary visual cortex
Eye
Optic nerve
Optic chiasm
Optic tract
Lateral geniculate body (thalamus)
Primary visual cortex (occipital lobe)

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Figure 10-29

Sensory input ⇨ Early analysis ⇨ Sensory store ⇨ LTM

How much information can our perceptual system hold?

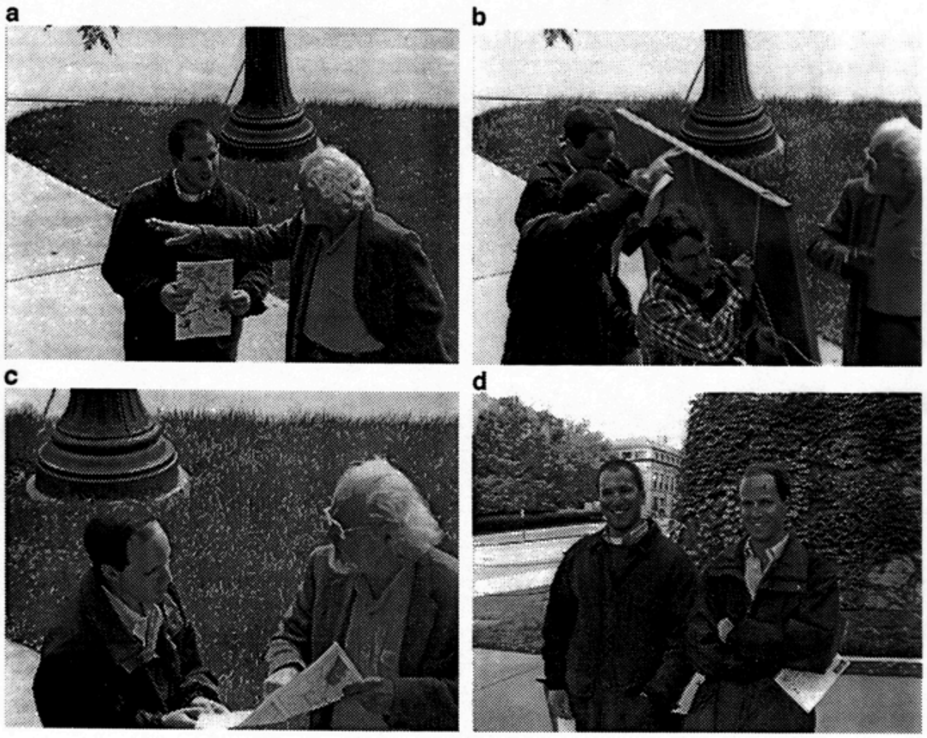
- What is the sensory store like?
  - How much information can the sensory store hold?
  - How long does it hold onto information?
- Consider first what our subjective experience is like …

Testing subjective impressions

Change blindness

(Simons and Levin, 1999)

- Experimenter approaches someone and asks for directions.
- During their conversation, two workmen carry a door and walk between them.
- Experimenter switches places with one of the workmen (wearing different clothes).
- Conversation is resumed. Afterwards, “subject” is asked if anything unusual happened.



Change blindness

- ➢What percentage of people notice that they are talking to a different person?
- ➢ONLY 50%!

But *I* would have noticed ...

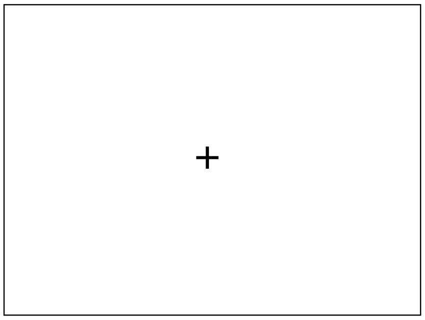
- Try it yourself:
  - http://people.usd.edu/~schieber/coglab/Rensink.html
- http://www.youtube.com/watch?v=6JONMYxaZ_s

What change blindness reveals

- **We are holding onto much less visual information than we think we are.**
- **Even when we are trying our best to pay attention, we have difficulty keeping track of this information.**

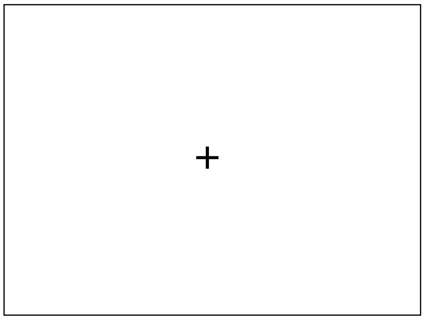
- **Must be some limits to the sensory register.**

Visual Report Technique

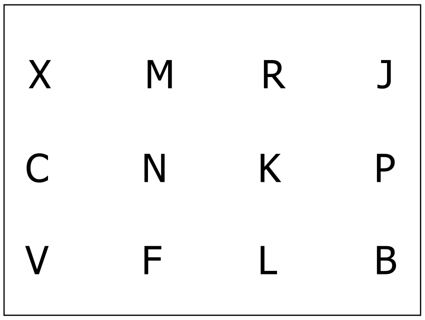


- **How much information can people extract from brief presentations?**

Visual Report Technique



Visual Report Technique

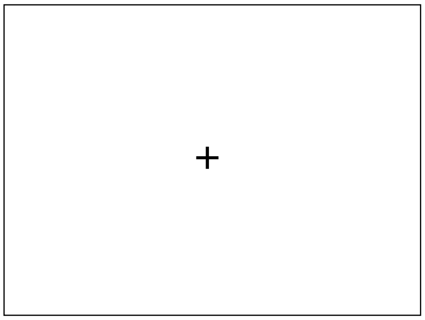


X M R J

C N K P

V F L B

Visual Report Technique



- **Report all the letters you can.**

Visual Report Technique

X	M	R	J
C	N	K	P
V	F	L	B

- **Typically, people can report 4-5.**
- **People complain that they “see” more but that the memory fades before they can report them all.**

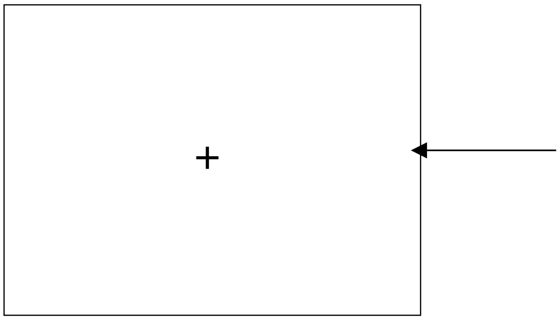
Partial Report Technique

+

Partial Report Technique

Q	B	E	D
J	I	P	L
R	W	M	H

Partial Report Technique



- Report all the letters in the indicated row.

Partial Report Technique

Q B E D
J I P L
R W M H

- Typically, people can report 3 out of the 4 letters.
- Suggests that we can hold about 3x3=9 items.

Partial vs. Full Report

- Partial report
  - can report ~3 of 4 letters (for any row)
- Full report
  - can report ~5-6 letters (of full set)
- Suggests distinction between initial perception and ability to report that information
  - initial perception held onto full set ~12 letters
  - can only report about ~5 at one time
- **Why is reporting limited?**

Properties of Iconic Memory

- **Visual sensory memory is known as ICONIC MEMORY.**

- **Capacity is fairly large.**
- **However, there is rapid decay.**
- **And the NEXT stage of processing (information that we can willfully hold onto) seems to be much more limited.**

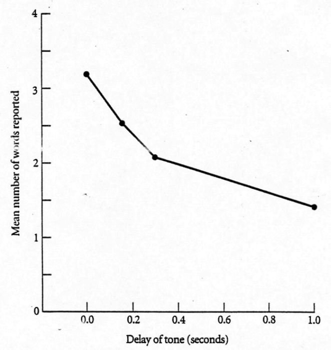


FIGURE 3.10 Results from Sperling's experiment. As the tone that signals the row to report is delayed, the number of items reported decreases. (Adapted from Sperling, 1960.)

Information limits

- **The earliest stages of sensory processing have a large capacity.**
- **However, later stages of processing are clearly limited.**
- **Theories of attention explain those limits and how we deal with them.**

What is the problem?

- Presented with more information than we can process.
- To accomplish our goals, need to:
  - Focus on some information (ignore some)
  - Divide our efforts among multiple tasks
  - Do some things without much effort

Outline

- **Sensory store (Iconic memory)**
  - limits on perception
    - change blindness
    - visual report
- **Focused attention**
  - **When does selection occur?**
    - early vs. late selection
    - text reading, cocktail party effect, dichotic listening
    - ERP evidence
  - **What type of information is selected?**
    - spaces
    - objects

Focusing in

- When we focus attention …
  - WHEN (at what processing stage) do we block information out?
  - WHAT KIND of features can we use to select information to block out?

FOCUSED ATTENTION:

Question 1

At what stage is information lost?

EARLY SELECTION

LATE SELECTION

Read the red words

(raise hand when finished)

Somewhere Among hidden the in most the spectacular Rocky Mountains cognitive near abilities Central City is Colorado the an ability old to miner select hid one a message box from of another. gold. We Although do several this hundred by people focusing have our looked attention for on it, certain they cues have such not as found type it. style.

Quiz

- What do you remember from the black text?

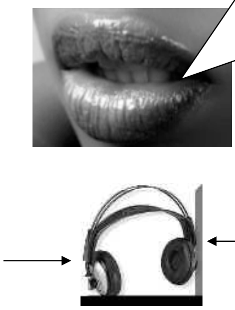
Studying attention

- **The Cocktail Party Effect (Moray, 1959)**
  - **ability to attend to a single speaker in a crowded, noisy environment**

Studying attention

- **Dichotic listening task (Cherry, 1953)**
  - 2 different messages are played into different ears
  - the participant must repeat (“shadows”) one of the messages aloud

From Cherry (1953)



... that religious convictions, legal systems and politics have been so successful in accomplishing ...

...that our religious conviction, legal systems and politics have been so successful in accomplishing their ends...

In attaining its present position, the institution, Gott würfelt nicht..

attended channel

unattended channel

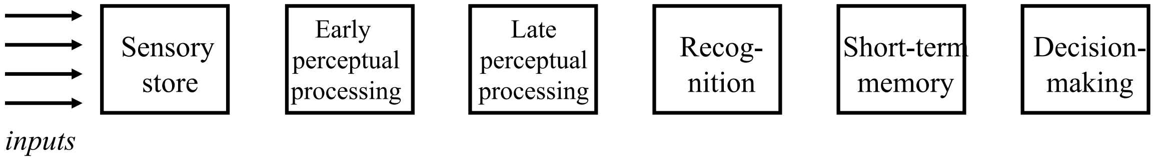
Dichotic Listening--Findings

- Participants could report little of the message in the unattended ear.
  - didn't notice if unattended message was in a foreign language, if words were repeated, etc.
- Participants do notice the gender of the speaker in the unattended channel.
  - suggests that physical, but not meaning-based, information got through.

Attention as a FILTER

- **Maybe attention acts like a filter, letting only some information pass through.**
- **If so, when does the dichotic listening data suggest that this filtering takes place?**

Generic model



Sensory store

Early perceptual processing

Late perceptual processing

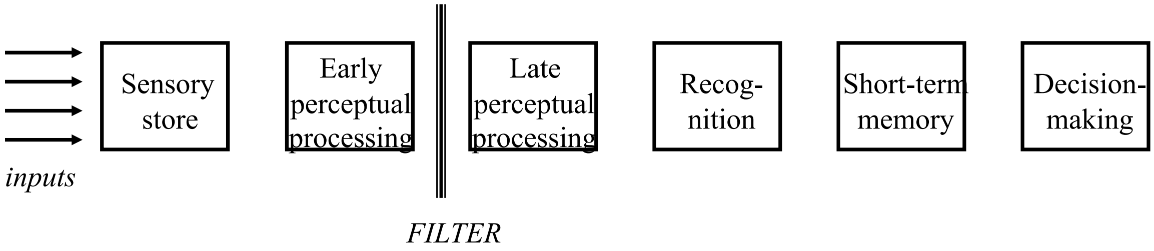
Recog- nition

Short-term memory

Decision- making

inputs

Early selection



inputs

Sensory store

Early perceptual processing

Late perceptual processing

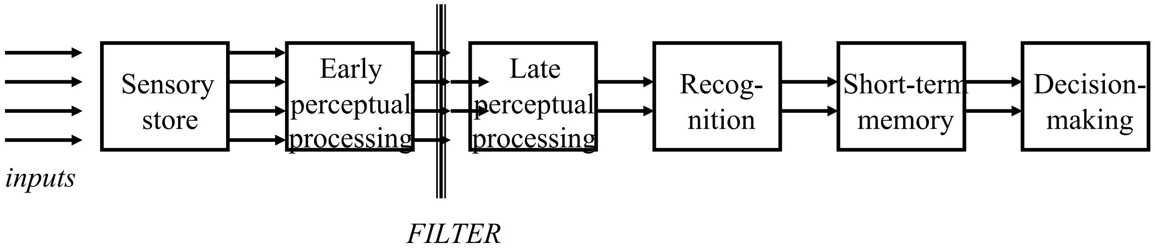
Recog-nition

Short-term memory

Decision-making

FILTER

Early selection



inputs

Sensory store

Early perceptual processing

Late perceptual processing

Recog-nition

Short-term memory

Decision-making

FILTER

Problems

Some “higher-level” information seems to pass through the filter.

- **People notice their own names.**

Individual differences

- Individ ɔ
  unatte
- Cockta 59)
  - Only name in an
    unat
- Who n
  - Indiv mory
    (Con

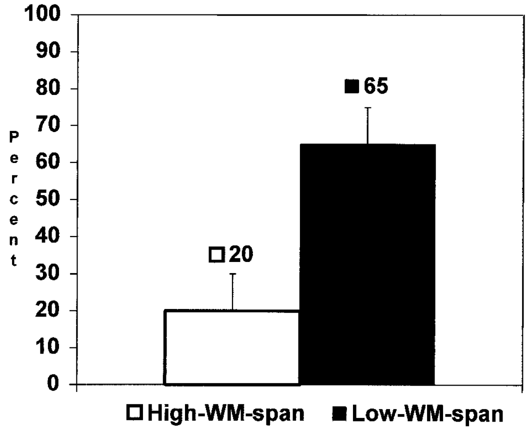


Figure 1. The proportion of high- and low-span subjects who reported hearing their name in the irrelevant message.

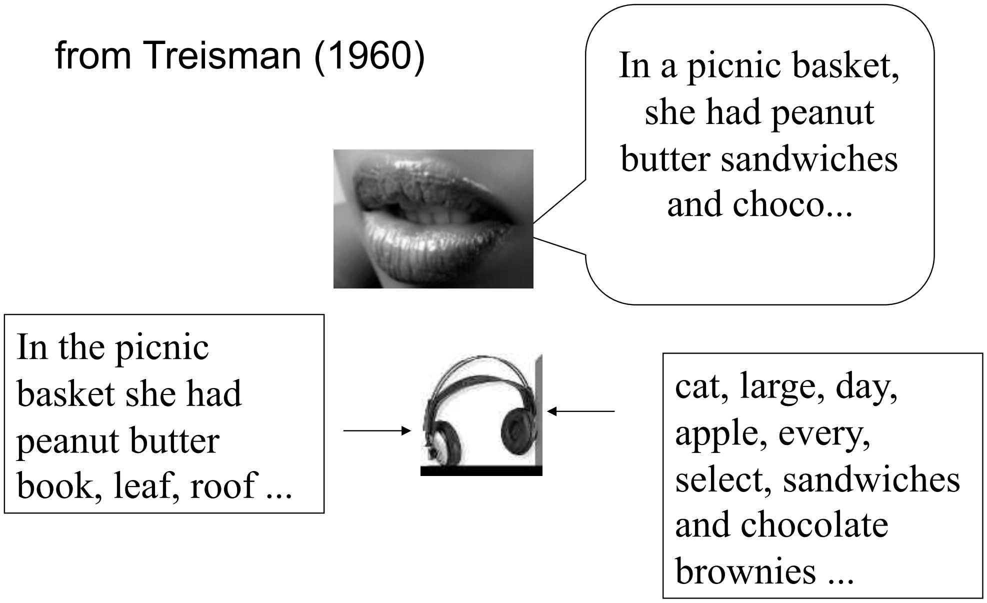
Problems

Some “higher-level” information seems to pass through the filter.

- **People notice their own names.**
- **People make shadowing mistakes.**

---

from Treisman (1960)



In a picnic basket, she had peanut butter sandwiches and choco...

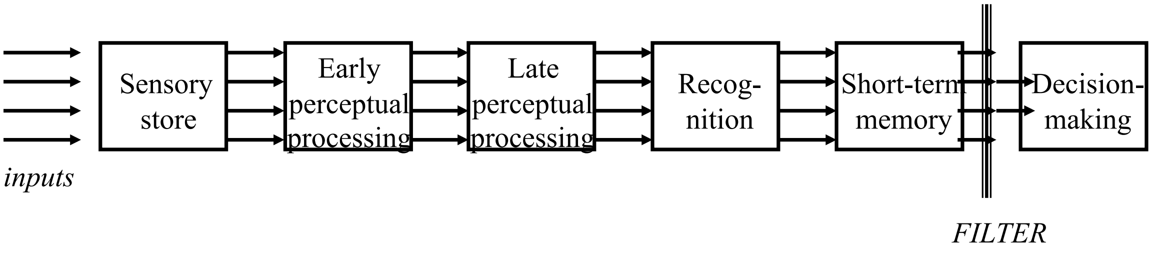
In the picnic basket she had peanut butter book, leaf, roof ...

cat, large, day, apple, every, select, sandwiches and chocolate brownies ...

attended channel

unattended channel

Late selection



Sensory store

Early perceptual processing

Late perceptual processing

Recog-nition

Short-term memory

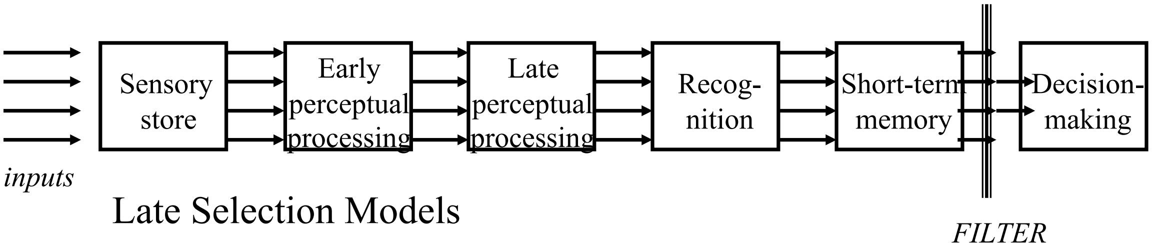
Decision-making

inputs

FILTER

Late selection

Deutsch and Deutsch (1963)



Sensory store

Early perceptual processing

Late perceptual processing

Recog-nition

Short-term memory

Decision-making

inputs

FILTER

Late Selection Models

- All info gets into short-term memory
- Unattended info rapidly forgotten
- Selection doesn’t occur until after recognition

When is selection?

- EARLY?
  - Selection during perception.
  - Some stimuli not analyzed for meaning.

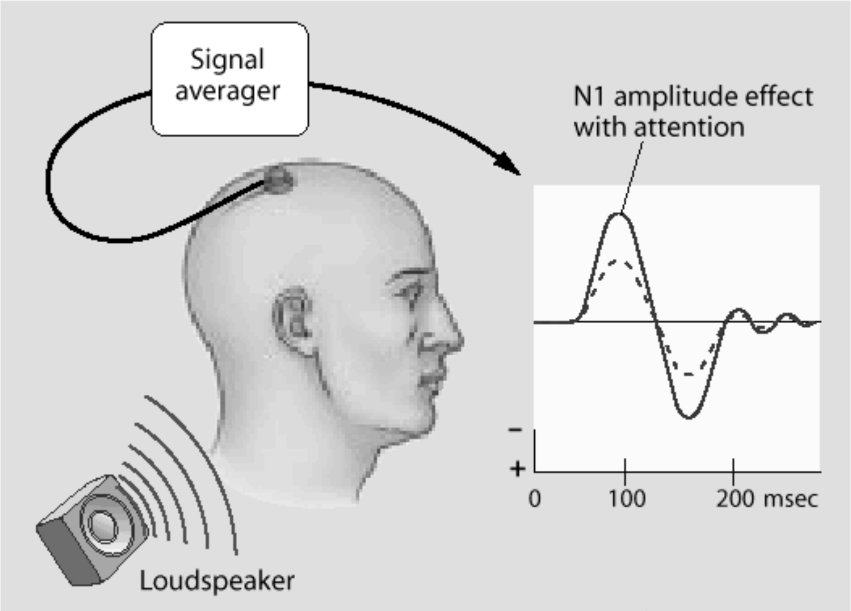
- LATE?
  - Selection after recognition. All stimuli analyzed for meaning, but some forgotten too quickly to be remembered later or responded to.

How can we differentiate?

Support for early selection

- Support for early selection from ERP studies of attention.
  - Hillyard et al. (1973) used a simplified tone version of a dichotic listening task.
  - Subjects asked to pay attention to tones in one ear and listen for target sounds.
  - Are to ignore all tones in other ear.
- N1 component is larger to attended tones.
  - Effect occurs by 60 ms!
  - Must be happening in early perceptual stages.

N1 larger to tone pips when attended



—— Attended ear response

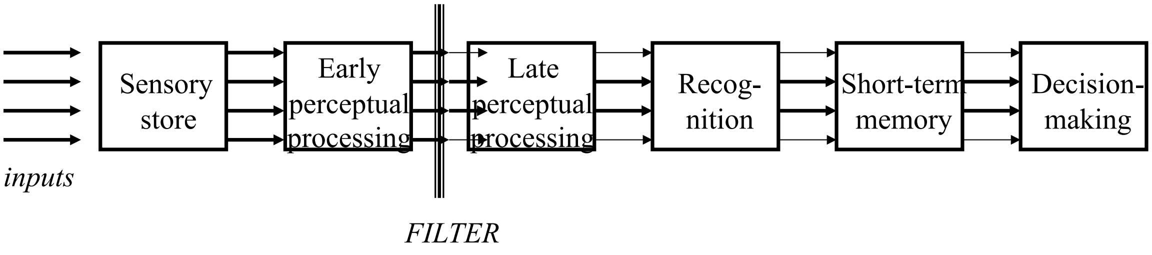
– – – – Unattended ear response

Updating the model

- ERP results show that some filtering DOES happen during perception.
- But unattended stimuli need not be *completely* blocked out.
- Attenuation model: variable amount of filtering at the perceptual level.

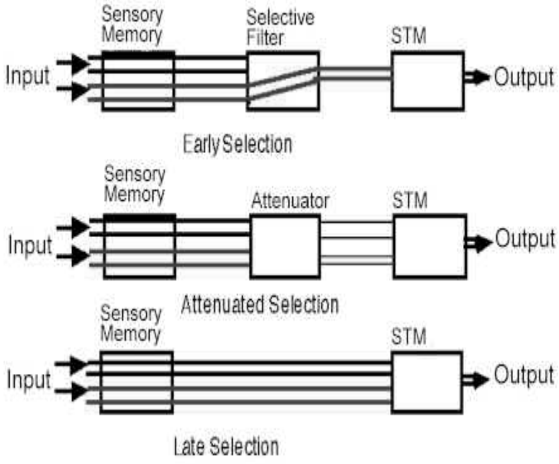
Attenuation Model

Treisman (1964)


Sensory store
Early perceptual processing
Late perceptual processing
Recog- nition
Short-term memory
Decision- making
inputs
FILTER

- A perceptual filter changes the relative strength of the input (without necessarily blocking it out completely).
- Amount of attenuation depends on the situation.

Summary



- Selection occurs early.
- But not just a simple physical filter.
- Amount and kind of selection has some flexibility.

Outline

- **Sensory store (Iconic memory)**
  - limits on perception
    - change blindness
    - visual report
- **Focused attention**
  - **When does selection occur?**
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    - text reading, cocktail party effect, dichotic listening
    - ERP evidence
  - **What type of information is selected?**
    - spaces
    - objects

FOCUSED ATTENTION:

Question 2

What kind of information is selected?

PLACES

OBJECTS

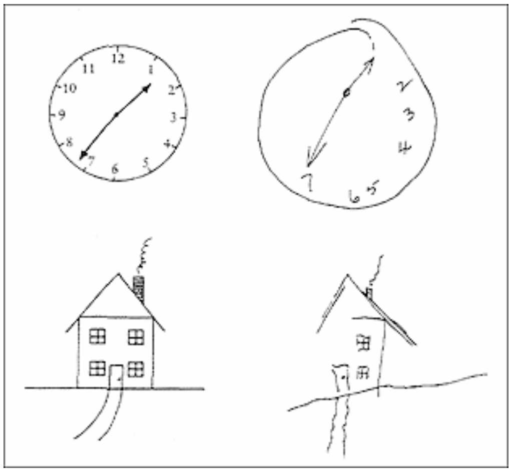
Evidence from patients

Hemineglect

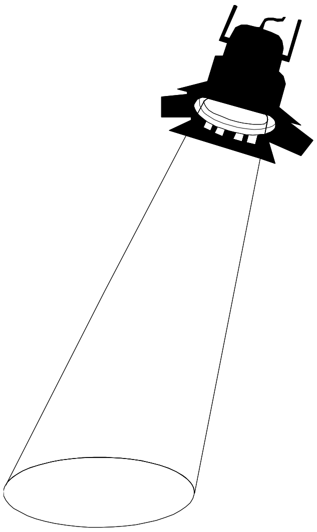
- Patients “ignore” one side of space (typically the left).
  - Eat food from one half of plate.
  - Draw half of objects.
  - Deny ownership of half of their body.

Suggests attention may be spatial.

Hemineglect

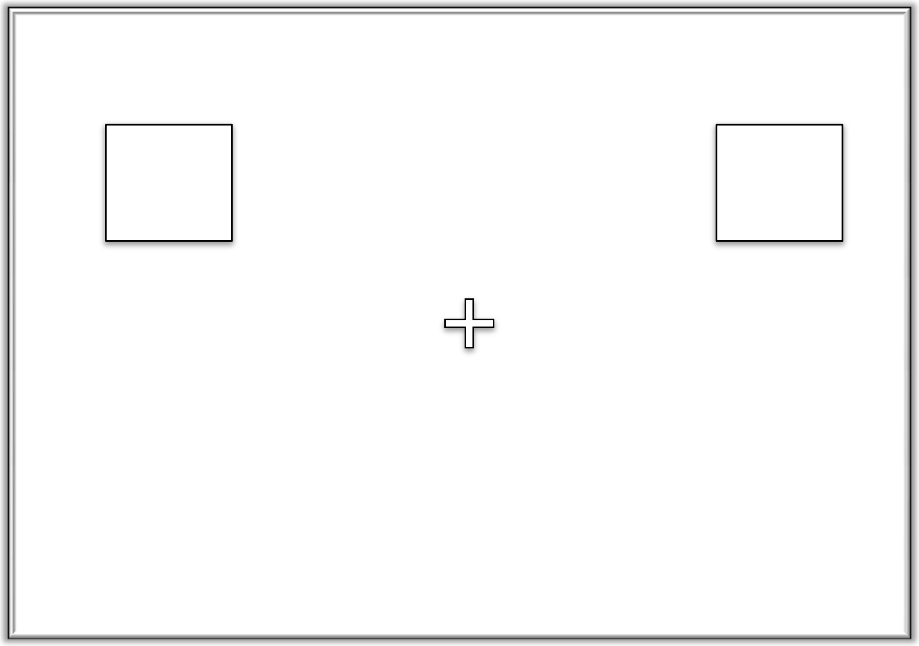


Attention may be like a SPOTLIGHT

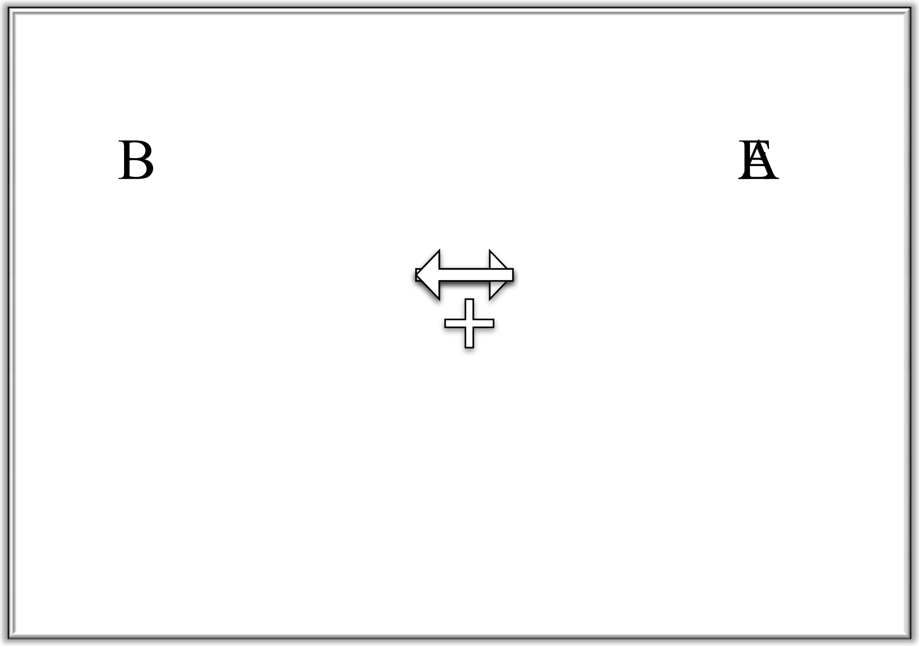


- Attention is like a “beam” of enhanced perceptual processing directed at some part of space.
- Beam has a particular size.
- Can move (“shift”) beam from one place to another.

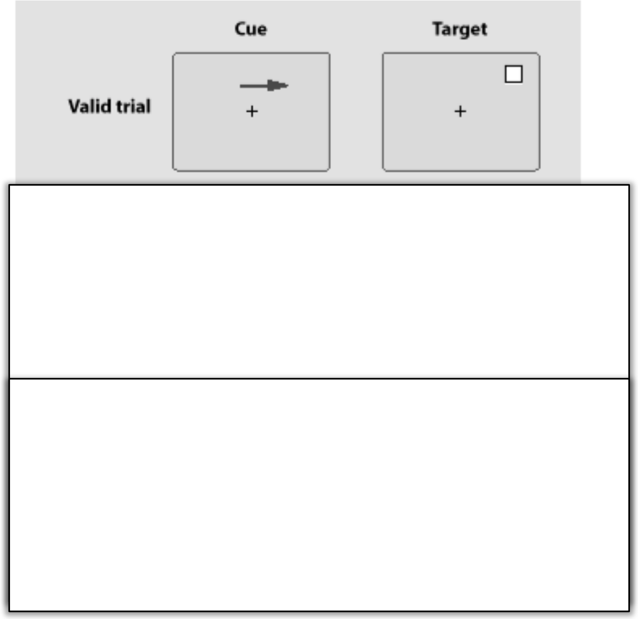
Spatial Cueing



Report letter



Priming of spatial location: covert orienting (Posner et al., 1980)



Expected →
(80%)

Unexpected →
(20%)

No expectation →

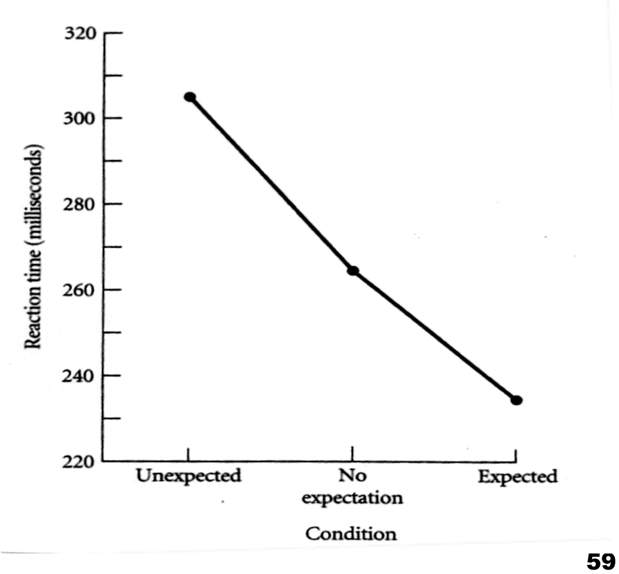
Priming of spatial location: covert orienting (Posner et al., 1980)

RESULTS

Benefit: Responses fastest when stimulus at expected location.

Cost: Responses slowest when stimulus at unexpected location.

Takes time to move attention from one place to another.



Object-based attention

- Objects also useful to attend to.
- Allow tracking as things move.
- Evidence:
  - Experimental
  - Balint syndrome

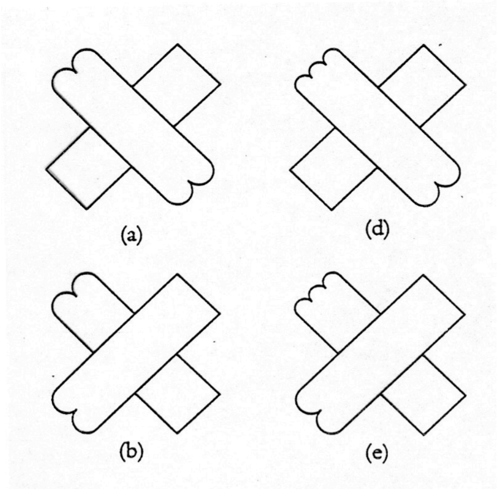
Behrmann, Zemel, & Mozer (1998)

- If attention is spatial only...
  - should be easier to attend to closer things.
- If attention can be object-based...
  - sometimes easier to attend to more distant things if part of the same object.
- Task: ask if ends have same or different numbers of “bumps”.

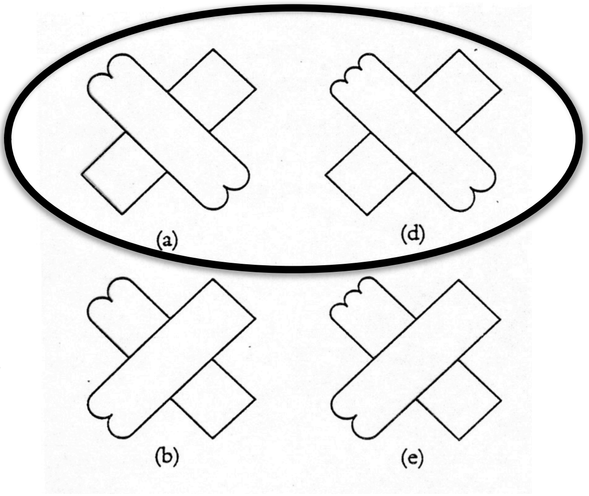
Behrmann, Zemel, & Mozer (1998)

Same object, but far

Close, but different objects



Behrmann, Zemel, & Mozer (1998)



Same object, but far

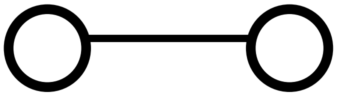
Close, but different objects

Evidence from patients

Balint’s syndrome

- **Patients can only attend one object at a time.**
  - **If shown red and green circles, report one or the other.**

  - **If two circles are connected with a line patients can report both.**



Suggests attention is object-oriented.

Space or objects?

Both are important.

- spatial info available early
- grouping happens automatically

Possible that we have strategic control over which “mode” we use.

Summary

When?

Much selection is early, but does not completely block out unattended stimuli.

What?

Evidence for both spatial and object-based.

Thought question

Suppose that you believe that ADHD is a “filtering problem”. That is, you think that individuals with ADHD have the same attentional capacity as individuals without this problem, but that they don’t select the “right” information to filter out. To test your hypothesis, you show children with and without ADHD some pictures of familiar objects to remember for later. You then test their memory for the pictures. How do you expect the performance of the two groups to differ? Now, suppose you test the same two groups of children on their memory for the posters that were hanging on the wall in the testing room. What do you expect to find and why?